Urbanization, socio-economic changes and population growth in Brazil: dietary shifts and environmental implications[1]

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1. Introduction

Population growth, economic globalization, improving living standards and urbanization are causing important changes in the global food system and modifying the dietary habits in many parts of the world (Molden, 2007; Godfray et al., 2010). The nutritional transition (linked to the development of countries and the increasing wealth of its population) implies a shift away from traditional staple food such as roots and tuber vegetables and a rise in consumption of meat and milk products, refined and processed foods, as well as sugars, oils and fats (Ambler-Edwards et al., 2009). The contemporary food system puts significant pressure on natural resources, especially on land and water, because the growing food demand pushes the agricultural frontier beyond, causing large impacts on ecosystems (Ambler-Edwards et al. 2009: 11-18). Also, the trend towards richer diets in animal proteins and processed food adds further pressure on the environment, since it requires larger amount of water and land to be produced (Allan, 2011; Mekonnen and Hoekstra, 2012).

Since 2008 more than 50% of the world population, over 3.5 billion people live in urban areas and it is projected that this proportion will grow up to 75% by 2050. Europe, Latin America and North America are already highly urbanized, whereas Africa and Asia have yet the lowest rates of urbanization (UNEP, 2013), but the tendency will continue and intensify in the future.

Urbanization trends and dietary shifts around the globe raise important challenges about the future of the global food and nutritional security, and the capacity of countries to guarantee a stable access to a healthy and nutritional diet (FAOb, 2012). Sub-nutrition and malnutrition are underlying problems in many countries around the world, and while in some cases they are

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related to the physical lack of food, in most circumstances they are linked with an insufficient purchasing capacity of the poorest to buy sufficient and nutritional value food (FAO, 2012b; Tscharntkea et al., 2012). In recent years the rise in food prices and its high volatility has depicted risks to the global food security (FAO, 2012b; Sage, 2013; Maye and Kirwan, 2013; Ambler-Edwards et al., 2009). Low-income households are particularly vulnerable to food prices shocks, since they spend a largest share of their incomes on food.

Latin America and the Caribbean (LAC) is one of the most important global food producers, but is still facing important food insecurity problems related to both mal-nutrition and sub-nutrition. LAC still has 49 million extreme poor people undernourished (≈ 8 % of total population) (FAOb, 2012).

According to FAO (2012a) and OECD-FAO (2011) it is expected that food prices will remain high and more volatile over the next ten years, which could threaten the progresses achieved and the future prospects of LAC's food security (FAO, 2012a). Prices volatility not only represents a threat to fight hunger but also limits the purchasing capacity of households, and encourages the consumption of cheap food of low nutritional value. Thus, solving the sub-nutrition and mal-nutrition problem in LAC requires a pool of measures, including greater food availability there where the hungry live, e.g. by using agro-ecological methods (De Schutter, 2011) and expanding food aid policies. Equally important, addressing poverty alleviation and promoting the adoption of healthier food habits through education is key to fight hunger.

The other side of the coin of food insecurity in LAC and probably the greatest challenge this region needs to face in relation to malnourishment, is obesity. LAC is the second region in the world with the highest percentage of population obese and overweighed (Finucane et al., 2011). Obesity affects today 20% of the Latin American population (> 110 million persons) and overweight affects up to 35% (> 200 million persons) (FAO, 2012a). In countries like Belize, Mexico, Venezuela, Argentina and Chile obesity affects close to 30% of the countries' population, whereas in Brazil and most Andean countries obesity affects nearly 20% of the population (ibid). Yet, the highest rates of overweight and obesity are found in those countries which are on a stage of nutritional post-transition (FAO, 2010). The underlying reasons behind this type of food insecurity are diverse and include economic as well as cultural factors.

In the case of Brazil, drivers behind nutritional transitions and hunger alleviation have been also linked to the increasing participation of households in the so-called *Conditional Cash Transfer Programs*. For example, the Brazilian Bolsa-Escola Program reported that over 60% of the transfers were used to buy food (Costa and Hermeto, 2008), which resulted in a higher consumption of staple food (grains -mainly-, fruits, legumes, vegetables, flour, milk, etc.) and non-staple (processed foods, meat, fish and other foods of animal origin), helping to diversify the diet (Costa and Hermeto, 2008). For Bolsa Família users, the total household expenses increased significantly compared to those who do not receive any benefit (the differences are greater among those with lower incomes). In the case of Bolsa Alimentação Program (later unified to Bolsa Família) the Ministry of Health of Brazil identified that user families spent more on food for each monetary unit provided by the transfer, and it has increased the amount and diversity of food consumed (Hermeto Camilo de Oliveira, 2007 quoted in Cecchini and Madariaga, 2011).

Besides understanding the significance of income and its relation to equitable access to food in quantity and quality, in recent years several methods have been developed to measure the impact of human consumption on the environment, such as the ecological footprint (Wackernagel et al., 1999) or the water footprint (Hoekstra and Hung, 2005). As López-Gunn et al. (2012) and O'Kane (2012) state, shifting dietary habits not only causes health problems but also large environmental problems.

Using Brazil as a case study, this paper discusses the relationship between demographic dynamics (mainly population growth, changes in income level and urbanization) and changes in food consumption patterns during the last two decades and the associated impacts that may arise.

2. Methods

2.1 Demographic and socio-economic analysis

Data about urban and rural annual growth rates and urban percentage of Brazil's population were collected from United Nation's World Population Prospects (2012 Revision).

2.2 Measuring the nutritional transition in Brazil

To measure the food consumption patterns of Brazilian citizens and account for the possible changes over we used the household surveys Pesquisa de *Orçamentos Familiares* (POF) for the years 1987/1988, 1995/1996, 2002/2003 available at IGBE (2013). POF surveys provide detail information on food consumption expressed in per capita terms based on different regional and socio-economic criteria. For the purpose of this assessment, we have summarized the information on food consumption (expressed in kg per capita) according to survey year, rural and urban population and income range. In doing so, we assess the temporal changes in food consumption, the impact of urbanization as well as the effect of income on food habits. The original data collected from the surveys was grouped into five major food typologies: vegetables and fruits; 2) cereal, legumes and tubers; 3) dairy products; 4) meat, fish and eggs, and 5) processed food, alcohol and sugary products.

2.3 The water footprint of the Brazilian diet

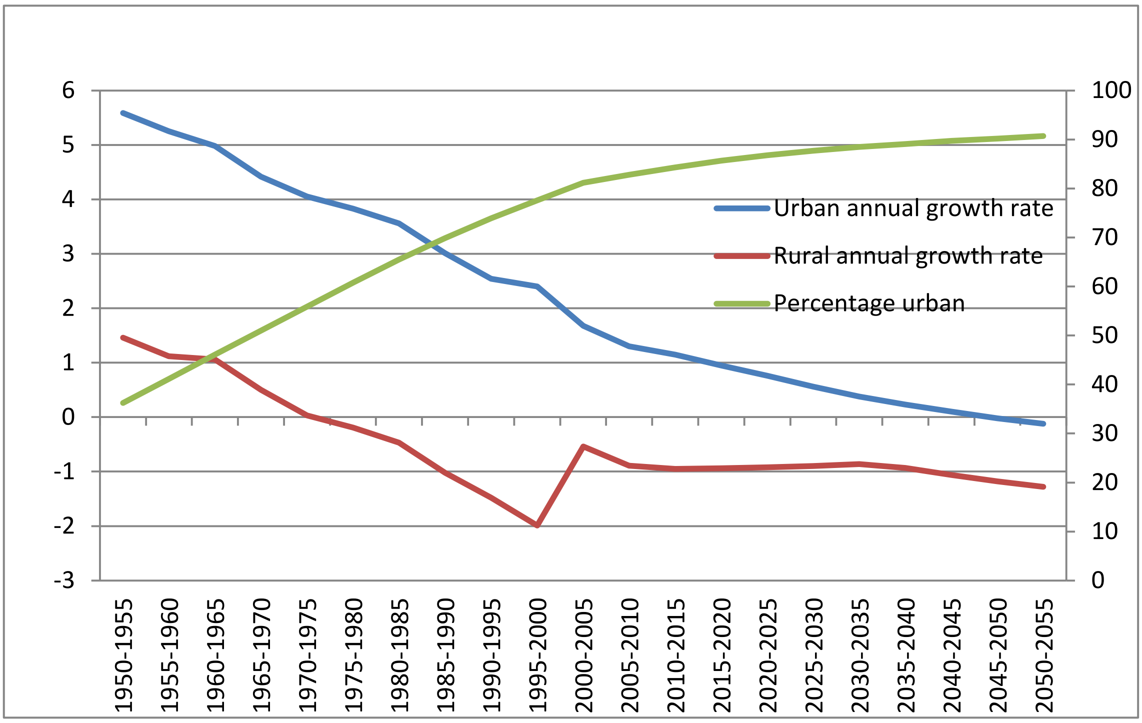
To account for the annual water requirements for sustaining Brazilians diets we used the water footprint (WF) indicator. The WF of a product is analogous to the concept of virtual water developed by Allan (1998) and quantifies the total amount of freshwater used to produce a good or a service (Hoekstra et al., 2011). Three different water sources of freshwater are considered when quantifying the WF: green water (soil moisture from rainfall); blue water (water from irrigation) and grey water (volume of water polluted resulting from the production of a good or a service). In this study, the WF of the Brazilian diet refers to the total amount of green and blue water embedded in the production of all the food items consumed in a given year (expressed in m^3/year). Data on the green and blue WF required to produce all the different food items consumed in Brazil (in m^3/ton) were obtained from Mekonnen et al. (2010). The grey WF of the Brazilian diet was not calculated due to data constrains. Because it was not possible to trace the geographical origin of the different food products Brazilians consume, we assume world average green and blue WF production values (in m3/ton) for the different food items consumed by Brazilians.

3. Population growth, urbanization and social transformations in Brazil

Why did we choose Brazil as a case study? Even though LAC accounts for only 8% of the world's population, its population trends are especially interesting. In particular, due to the growth rates showed by its population throughout the 20th century (urban population accounts for more than three quarters of the Latin American population), as well as the speed with which the demographical and social changes have been developing over the 21st century. Fertility levels, measured by the Total Fertility Rate (which is below replacement level in many Latin-American countries of relevance, including Brazil) and the formation of a significant urban middle class are examples of this.

Studying some of the challenges imposed by these changes is thus vital. Urban growth in low and middle-income countries is likely to be the most influential process on social, economic, political and environmental trends of the 21st century (Martine and McGranahan, 2010). So, studying the interrelation between these demographic changes and the use of resources in Brazil is a good starting point to move towards general conclusions. For instance, to formulate hypotheses that enable a better understanding of food consumption patterns under rapid urbanization processes, such as those taken place currently in many Asian and African countries.

Figure 1. Urban and rural annual growth rates and urban percentage (Brazil, 1950-2055)



Source: Own elaboration based on data from World Population Prospect (2012 Revision)

Brazil is a very significant case, due to both its fast population growth and its urbanization level; they are both part of deep transformations taken place over a few decades. Brazil's total population underwent an explosive growth from nearly 71 million in 1970 to today's nearly 200 millions, becoming the fourth most populated country in the planet. This is one of the cases where the speed of the demographic transition in Latin American countries is more evident. This growth in population was mostly made up of a high urban growth, as a result of two factors: the natural growth of urban population and rural-urban migration.

En 1950 Brazil's urban population was 36.2%. According to the last census, in 2010 84.45% of Brazilians lived in cities (IBGE, 2011). From a demographic point of view, this fast growth is explained by the growth rates of urban and rural population. During the 1950s and 1960s, Brazil enjoyed extremely high urban growth rates of around 5% annual, while its rural population begun to undergo a negative growth by the end of the 1970s.

Today, Brazil is going through the last stages of its urban transition (the urban growth rate has slowed now and it is close to stagnation, with an overwhelming majority of people living in cities). However, significant urban growth is still to be seen, particularly in the outskirts of the larger cities, where the main challenge will be to cope with the housing-related problems of the lower-income strata (Martine and McGranahan, 2010). Brazil's population dynamics will almost exclusively be that of its cities, where not only does it concentrate most of its population but also 90% of its Gross Domestic Product (GDP).

The demographic trends will consolidate giving way to new production, consumption, transportation and housing patterns. The rest of the region will show a similar trend. Urban and rural growth rates seen in Brazil show similar trends to those of other overpopulated countries such as Mexico and overall Latin America where urban population has increased 240 per cent over the last three decades, whereas rural population has only grown 6,1 per cent (UN, 2012).

Along with urbanization and population growth, the occupational structure and social stratification patterns have been modified. One of the most relevant changes in LAC (and particularly in Brazil) is the recent constitution and increase of an urban middle class. From 1987 until 2000, the real salary did not show significant changes (Cooney, 2007). In fact, during the last two decades of the 20th century the distribution of the income in Brazil did not show significant variations since the lowest quintile concentrated almost 4% while the highest one about 60% (González, 2011). But from the beginning of the century its Gini coefficient dropped from 0.596 in 2001 to 0.543 and the reduction of poverty showed the most spectacular figure, falling from 37.5% to 20.9 in a ten-year period (2001 to 2011) (ECLAC, 2012).

Brazil's social stratification structure has also changed. Middle class households have more than doubled: from 9.3 millions in 1990 to 20.8 millions in 2007, which represents an increase from 36% to 46% of total households. In addition, Brazil is along with Mexico one of the two countries that most increased their participation of women in the labor market over the last two decades (Franco, Hopenyan and León, 2011). The two countries together account for two thirds of LAC’s GDP.

It is plausible to assume that all these demographic and socio-economic changes have consequences as to the relation between populations and their food consumption patterns, which have notorious impact on the use of Brazil's natural resources.

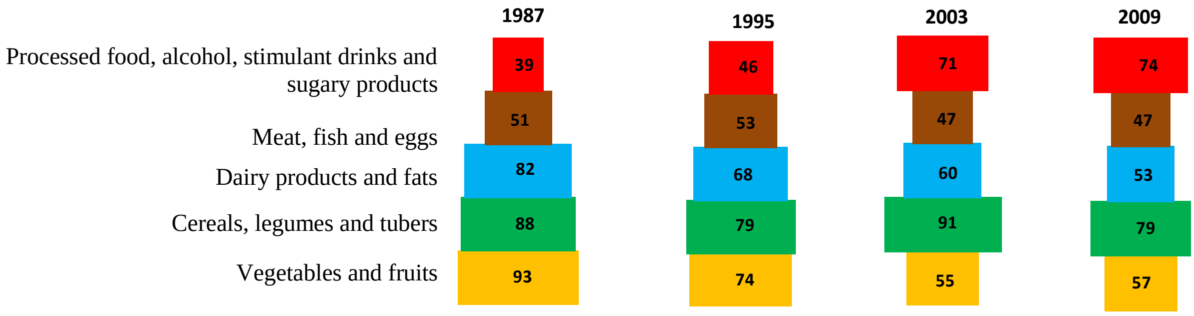
4. Diets and underlying factors behind changing food consumption patterns

Since 1987 important changes have occurred in the food consumption patterns of Brazilian citizens (Figure 2). In absolute terms, food consumption per capita has decreased over time from 360 kg per capita in 1987 and 325 kg per capita in 1995 to 315 kg per capita in 2009. But most importantly, the composition of the diet has experienced significant changes over time. In 1987 Brazilians had a balanced diet with a predominant intake of vegetables, fruits, cereals and legumes (around 90 kg per capita per year, respectively). Rice, native tubers like *cará*, potatoes, beans and tropical fruits like bananas and citric were fundamental components of the diet prior to 1990. The third group of most consumed food products in 1987 were dairy products, particularly milk, which accounted for 75% of the dairy product consumption. Animal protein consumption in the late 80s was relatively high (> 50 kg per person per year) close to the average animal protein intake of richer regions like Europe around 1990 (≈ 60 kg per person per year) (Westhoek et al., 2011). The most important sources of animal protein consumption in Brazil in the late 80s was beef (37% of total intake) followed by pork (25%). Sugar and spirits are the two most important consumed products on the top of the food pyramid.

Ever since 1987 important changes have taken place in the composition of the food pyramid. Overall, the intake of vegetables and fruits and dairy products has decreased significantly (between 36 and 38%), whereas the consumption of processed food, stimulants and sugary products has experienced a dramatic increase (80%). Yet, Brazilians eat twice as much sugar as in 1987, 30% more of processed food and almost 50% more non-alcoholic drinks like spirits and mineral water. The largest reduction in vegetables and fruits consumption is due to the lower intake of citric and local tubers.

Among the dairy products, the largest reduction is due to the lower intake of milk (from 68 liters per capita in 1987 to 40 liters in 2009). This sharp reduction has also been observed in other Latin America like Mexico (Santos-Baca, 2012), and could be partly a response to the existing volatility of food prices. Nevertheless, the reduction in dairy products probably is not just a price signal response but also related to other masked processes occurring within the milk sector of Brazil, since the trend all over the study period (1987 to 2009) is negative. Yet, the average consumption of milk intake remains below the global average of 82 liters per capita (FAO, 2011).

Figure 2. Food consumption pyramids (in consumed kg per capita per year) (Brazil, 1987-2009)

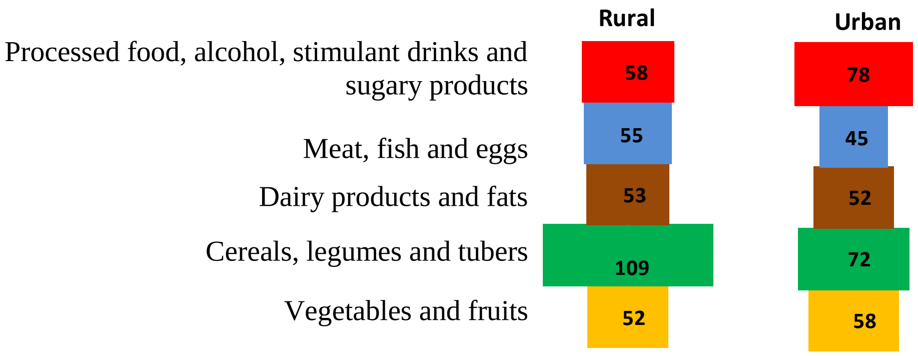


Source: Own elaboration based on Pesquisa de Ornamentos Familiares for the years 1987/1988, 1995/1996, 2002/2003 and 2008/2009 (IBGE, 2013).

In summary, the nutritional transition in Brazil occurred in the late 90s and early 00s, overlapping with the economic takeoff of the country. Nevertheless, and compared to the prevailing trend in other developed regions, diet changes in Brazil have not translated into a greater consumption of animal protein but just of food items linked to urban lifestyles.

Figure 3 compares the diet composition of rural and urban citizens in Brazil by 2009. Urbanization has clearly on effect on the way people eat. On one hand, urban citizens are more sedentary, which reduces the requirements for calorie intake. In rural areas average food consumption is higher than in urban areas (335 and 310 kg per capita per year, respectively). However, the most important differences between rural and urban food consumption in Brazil are pretty much related with the composition of the food pyramid. Rural people in Brazil ingest larger quantities of vegetable and animal protein. In fact, the consumption of cereals and legumes in rural areas is 30% higher, particularly of maize. The intake of meat in rural areas is slightly higher compared to urban areas (55 to 45 kg per capita), although in both context beef in the most consumed type of meat.

Figure 3. Average food intake in rural and urban areas in Brazil, 2009.



Source: Own elaboration based on Own elaboration based on 2008/2009 Pesquisa de Ornamentos Familiares (IBGE, 2013).

Urbanization not only implies more sedentary lifestyles, but also greater access to a wide range of food markets and products, which often impacts food habits. As Figure 3 shows, urban citizens in Brazil consume 30% more high-calorie products like processed food and sugary products than rural citizens. This increase is related with a higher consumption of prepared food and foremost sugar spirits like coke and other stimulants. Mineral water consumption in urban areas is also higher compared to rural areas, which might be linked to two causes. The low reliability of urban waters sources and/or the increasing fashion of buying bottled water.

A critical factor underlying changes in food consumption patterns is related with the income level and the share invested in buying food. As income grows, purchasing power increases and allows for greater consumption of more expensive food items like meat or fish. Figure 4 shows the wide differences in food composition and quantity intake among the different income groups. Among the poorest, the basic elements of their diets are vegetable proteins like rice and beans (*feijão*), which account for almost 50% of the average food intake. However, as income grows, the consumption of animal protein increases, particularly dairy products like milk and cheese and also beef meat and the vegetable proteins and vegetable consumption does not represent more than 40% of the total food intake.

According to the WHO (2013), in Brazil between 2002 and 2009, overlapping with the nutritional transition period, the prevalence of overweighed women has increased from 40 to 43% and obesity has also increased from 13% to 16%. Despite the lack of concrete data on the associated illnesses related to overweight and obesity, it is clear that such trend has important social costs in terms of health, and requires further analysis.

5. Environmental implications linked to changing food consumption.

Table 1 shows the blue and green WF of the average Brazilian diet and the overall WF of food consumption in Brazil for the time period 1987-2009. Yet, 92% of the WF of Brazilian diet is of green nature, and just 8% is blue. This large share of green water evidences that the Brazilian diet is mostly composed of products that have been produced in rain-fed agriculture, and therefore the largest environmental impacts associated to food consumption are at the land use level, above those generated in freshwater ecosystems[2]. This is to a large extend explained by existing climatic conditions, which favor the production of most vegetable proteins and vitamins without irrigation and the prevalence of extensive livestock production.

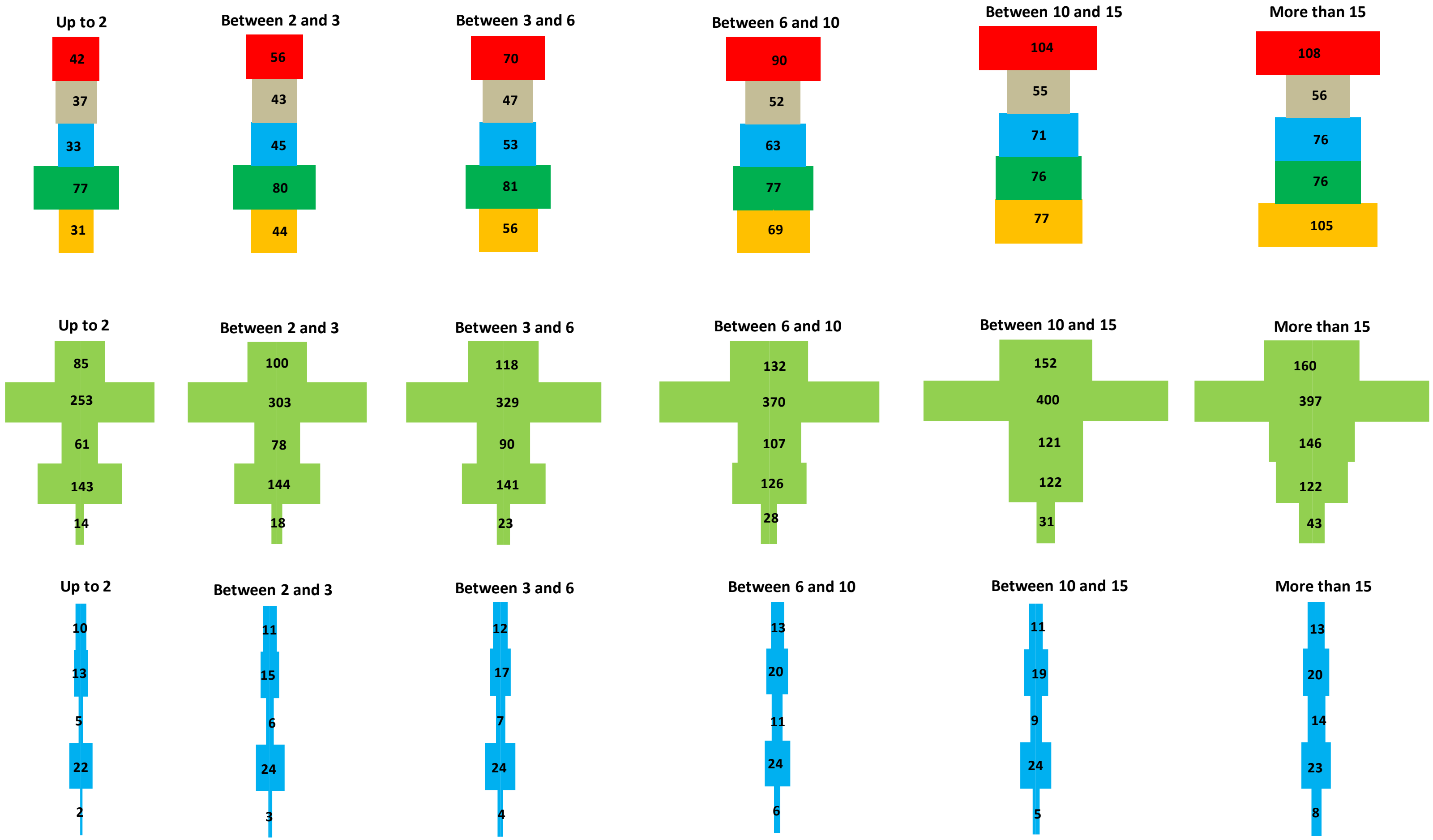
Table 1. Green and blue water footprints of an average Brazilian diet (m^3 per capita per year) and overall water footprint of Brazil's food consumption (10^6 m^3), 1987-2009.

	1987	1995	2003	2009
Green WF	791	774	745	706
Blue WF	72	68	70	65
Total WF (green + blue) (m^3/cap/year)	**862**	**842**	**816**	**770**
Population	141,767,626	161,890,816	181,752,951	193,490,922
Brazil's WF linked to diets (million m3/year)	**122,219**	**136,231**	**148,239**	**149,065**

Source: Own elaboration based on IGBE (2013) and World Bank (2013) data.

[2] The grey WF was not considered in this study, thus the potential impacts on freshwater ecosystems -in terms of the pollution caused in the food production process-has not been measured nor assessed.

Figure 4. Current food consumption (Kg per capita per year) and associated green and water footprint (m^3 per capita per year) of Brazilians according to their income range.

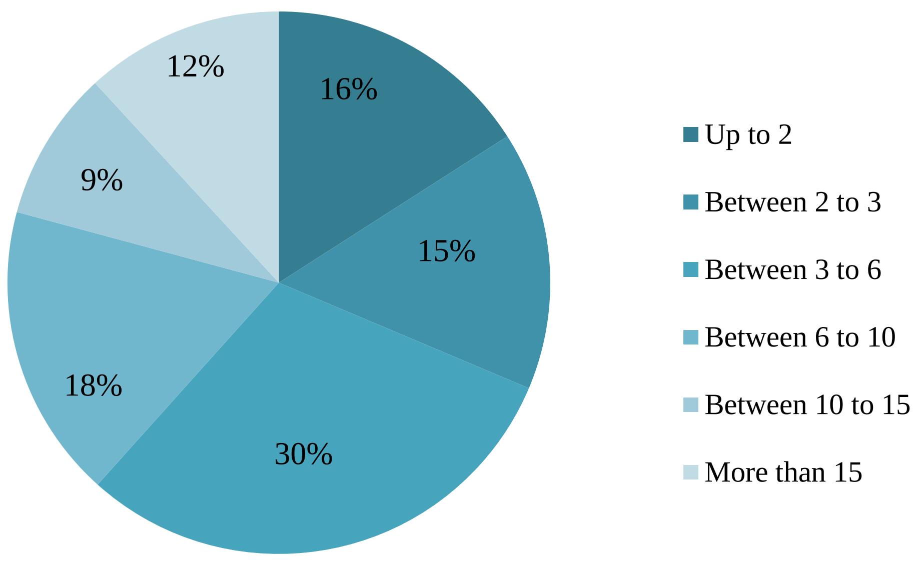


Source: own elaboration based on data from POF 2008/2009 and WFN (2013).
Income ranges represent multiples of the minimum monthly wage in Brazil as by January 2009 (R$ 415, equivalent to 178.5 USD).

Despite the changes observed across the food pyramids since the 80's among Brazilians (Figure 2), those have not translated into greater WF. In fact, the actual WF of an average diet in Brazil equals ≈ 770 m^3 per capita per year, 11% smaller compared to the one of 1987. The increase in the WF linked to the growing consumption of processed food and sugary products in 2009, has been compensated by the reduction in the WF linked to the consumption of cereal, legumes and dairy products. Overall, the WF of food consumption in Brazil has increased from 122,219 million m^3 in 1987 to over 149,000, but this increase responds foremost to the increase in population and not to an increase in per capita terms.

Figure 4 shows the green and blue WF of the Brazilian's diet classified according to their income range. The differences in the diet's WF are remarkable, ranging from the 610 m^3 per capita per year from the poorest Brazilians to the almost 985 m^3 per capita per year consumed by the richest. Overall, the poorest (those with salaries up to 2 times the minimum monthly wage) consume 16% of the total WF although they represent over 20% of the total population in Brazil, whereas the richest (those earning more than 10 times the minimum wage) represent 16% of the population but consume over 17% of the national WF of food consumption (see Figure 5).

Figure 5. Percentage of the Water Footprint (WF) of actual food consumption in Brazil for the different income groups



Source: Own elaboration based on IBGE (2013)
Income ranges refer to the number of times the monthly salary surpasses the minimum wage set for February 2009.

5. Final remarks

It is not uncommon to see news titles as "Urbanization threatens food security"[3]. Considering the trends presented on section 3 of this paper (population growth, fast and massive urbanization, growth of the middle classe), remarkably evident for the case of Brazil, one of the key questions of the paper was straightforward: how has food consumption evolved over the years in which such social and demographic transformations occurred? Even if it is too difficult (and beyond the scope of this paper) to establish a causal relation between both group of factors, the existence of a change in food consumption patterns could be regarded as a provisional confirmation of a global transformation in which socio-economic and demographic factors would be seen as one of the most determining factors of such change.

The relation between demographic change and food consumption is of vital empirical importance for a number of economic, environmental, health and political reasons. As stated on Albisu et al. (2011), although it has been claimed by some authors that the demographic profiles of people are not as determining of the food consumption patterns as other variables, most evidence suggests that population growth and change in the composition of the population modify patterns of food consumption. This change in the composition of the population is brought about by urbanization, changes in age structure, patterns of use of time and increase of income (in countries like Brazil, which has undergone significant processes of upward social mobility), among other factors.

The risks arisen from a change in the world's dietary patterns are usually mentioned. As regards urbanization, for example, it is not that population growth (and particularly urban growth) is threatening food production as large urban areas cover more space while crops are reduced to smaller areas. The risks are about the competition between food and energy crops that become increasingly larger, as well as the aforementioned changes in the dietary patterns of the growing urban middle classes who prefer eating more meat instead of other crops.

Specifically, aggregated data assumed this kind of conclusions over the last decade:

> *“the amount of meat consumed in developing countries over the past has grown three times as much as it did in the developed countries. Poor people everywhere are eating more animal products as their incomes rise above poverty level and as they become urbanized. By 2020, the share of developing countries in total world meat consumption will expand from the current 52% to 63%. By 2020, developing countries will consume 107 million metric tons (mmt) more meat and 177 mmt more milk than they did in*

[3] http://www.foodnavigator.com/Financial-Industry/Urbanization-threatens-world-food-security

> *1996/1998, dwarfing developed-country increases of 19 mmt for meat and 32 mmt for milk"* (Delgado, 2003).

Besides the great variance within the group of developing countries, this general trend as to the growth of certain food groups is most often observed and was a very plausible hypothesis in our study. In fact, a recent line of investigation is trying to relate the prospects of urbanization to the potential crisis that would arise in terms of food safety shortages (Matuschke, 2009) and changes in consumer preferences.

If it is true that *major shifts in dietary patterns are occurring* (Kearney, 2010), these changes are not extremely recent in Brazil's history, as they occurred in the late '90s overlapping with the economic takeoff of the country. Somehow surprisingly, diet changes in Brazil have not translated into a greater consumption of animal protein (probably because Brazilians already had great consumption of meat). They did translate into a greater consumption of food items linked to urban lifestyles. Urban citizens in Brazil consume 30% more high-calorie products like processed food and sugary products than rural citizens.

Despite the changes in the food pyramids, we do not observer a greater WF (mainly because the increase in the WF linked to the growing consumption of processed food and sugary products has been compensated by the reduction in the consumption of cereal, legumes and dairy products). But per capita figures tend to hide important differences. In Brazil the more you earn, the more you eat, making the WF of the rich greater. Differences range from the 610 m^3 per capita per year from the poorest Brazilians to the almost 985 m^3 per capita per year consumed by the richest.

In conclusion, Brazil data suggest that the nutritional transition can be seen as a specific transformation for each country and not as completely uniform within the developing world. In fact, "*the diverse nature of this transition may be the result of differences in socio-demographic factors and other consumer characteristics"* (Kearney, 2010)

In Brazil, a growing population and middle class, together with a fast growing urbanization came along with the change in food consumption patterns, as expected. But again, these changes are country-specific and the Brazilian case does not exactly replicate general trends. Further research should focus on explaining the probable causal link between demographic change and nutritional transition in each country in particular. The challenges ahead include "key issues with regard to agriculture and urbanization (such as) whether the growing and changing demands for agricultural products from growing urban populations can be sustained" (Satterthwaite et al., 2010).

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